

location and type of padding and the configuration of the frame. Likewise, these previous facemask assemblies do not
5 hold the night vision goggles in position for the user to use them properly during physical operations such as running, jumping, crawling and rolling.

Also, previous facemask assemblies did not provide proper night vision goggle positioning adjustments allowing the user
10 to properly position the goggles in front of his or her eyes to maximize the benefit of the night vision goggles' field-of-view and eye relief. Previous facemask assemblies further did not provide a fold-away function allowing the facemask assembly to be folded into a compact shape for storage.
15 Moreover, previous facemask assemblies did not provide a quick-release mechanism allowing the user to quickly remove the facemask assembly from his or her head. Finally, previous facemask assemblies mandated the use of a chin cup.

20 SUMMARY OF THE INVENTION

In one embodiment, the present invention provides a facemask assembly for night vision goggles comprising a frame assembly, a mount assembly for attachment of the night vision
25 goggles, an adjustment strap assembly, and a neck pad assembly, wherein the frame assembly is generally C-shaped and contoured to extend across the upper forehead of a user, with each end of the generally C-shaped frame assembly extending down around the outside of the eyes and to the hollow of the cheeks of a user, below the cheek bones and above the jaw.
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In an alternative embodiment, the present invention provides a facemask assembly for night vision goggles comprising, a frame assembly; a mount assembly for attachment of the night vision goggles, an adjustment strap assembly and
35 a neck pad assembly, wherein the frame assembly is hinged to allow rotation of at least one portion of the frame assembly

with respect to the remainder of the frame assembly through a limited range of motion between an open configuration for use and a folded configuration for storage.

In yet another alternative embodiment, the present invention provides a facemask assembly for night vision goggles comprising, a frame assembly, a mount assembly for attachment of the night vision goggles, an adjustment strap assembly, a neck pad assembly, and a protective pad positioned on top of a user's head when the facemask assembly is being worn to protect the user's head from injury from the night vision goggles when in a stowed position.

15 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment of a facemask assembly of the present invention.

FIG. 2 is a perspective view of a frame assembly of the facemask assembly of FIG. 1.

FIG. 3 is a perspective view of a hinge end of a frame member of the present invention.

FIG. 4a is a side view of one surface of a frame member of the present invention.

FIG. 4b is a side view of the opposite surface of the frame member of FIG. 4a.

FIG. 5 is a top view of a bridge of the frame assembly of FIG. 2.

FIG. 6a is a front view of a hinge pin of the frame assembly of FIG. 2

FIG. 6b is a side view of a hinge pin of the frame assembly of FIG. 2

FIG. 7 is a perspective view of an interior of a pad of the present invention.

FIG. 8 is a perspective view of an alternate

configuration of an adjustment strap assembly of the present invention.

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DETAILED DESCRIPTION

10 The facemask assembly **10** of one embodiment of the present invention is designed for maximum comfort and stability. This has been accomplished through the shape and padding of the facemask frame, as well as the neck pad and strap adjustments. The design also provides sufficient stability of night vision goggles during quick movement operations and allows the user to align the optical axis of the night vision goggles to his or her line-of-sight for optimal viewing.

15 In one embodiment as shown in FIG. 1, the facemask assembly **10** may comprise a frame assembly **20**, a mount assembly **80**, an adjustment strap assembly **96** and a neck pad assembly **98**. The frame assembly **20** serves as the foundation for the other remaining components of the facemask assembly **10**. The frame assembly **20** is designed to properly fit the differing anthropometric shapes of the 5th to 95th percentile human head. Further, the curvatures of the frame assembly **20** fit the human face in a manner which minimizes discomfort by avoiding sensitive areas of the face and by spreading the load area over sufficient surface area.

20 In one embodiment, the facemask assembly **10** includes a frame assembly **20** as shown in FIG. 2. The frame assembly **20** may comprise a first frame member **23**, a second frame member **24** and a bridge **26** between the first and second frame members. The second frame member **24** is a mirror image of the first frame member **23**. Therefore, for clarity, only the first frame member **23** will be discussed in detail.

25 The first frame member **23** may comprise a body **40**, a hinge end **27**, and a cheek end **44**. As shown in FIG. 3, the hinge end

27 on the first frame member 23 includes an upper cylinder 28 and a lower cylinder 30 separated by a recess 32 adapted to receive an arm 82 from the bridge 26 (discussed in more detail below). The upper cylinder 28 may have an opening 34 running through the length of the cylinder adapted to allow a hinge pin 36 to be passed therethrough. For instance, the opening 34 may be hexagonal in cross section at an upper end and circular in cross section at a lower end in order to receive and be consistent with the shape of a head and upper shaft of the hinge pin 36. The hexagonal cross section upper end and hexagonal head act to hold the hinge pin in place and to prevent rotation of the hinge pin relative to the frame member. Similarly, the lower cylinder 30 may also have an opening 38 adapted to allow a lower shaft of the hinge pin to be passed therethrough. The opening 38 may have a flat or a non-circular cross section however, to provide a stop on which the inserted hinge pin 36 may rest to assist in preventing it from rotating relative to the frame member.

Extending from the hinge end 27 of the first frame member 23 is the body 40. The body 40 of the first frame member 23 is designed to generally follow the contour of a human face from the upper forehead above the eyebrows, around the eyes and to the hollow of the cheek below the cheek bones and above the jaw. One example of a shape of the body 40 is shown in two dimensions in FIG. 4a and in three dimensions is described by data provided in Appendix A corresponding to the points shown in FIG. 4b. The data are points in a Cartesian coordinate system and, when entered into an appropriate software application, such as **ProE**, or **CAD**, the resulting points cloud will provide an exemplary three-dimensional shape of the body 40 of the first frame member 23.

In one embodiment, the body 40 is substantially C-shaped and tapers outward to form the cheek end 44. Although the

exact width of the body **40** is not critical, the body should be wide enough to provide enough surface area so that correspondingly-sized padding (to be discussed in more detail below) attached to the body provides comfort to a user wearing the facemask assembly **10** for long periods of time. However, the body **40** should not be so wide as to make the facemask assembly **10** unduly heavy, bulky and difficult to store. In one particular embodiment, the body **40** has a minimum width of about 1 inch near the hinge end and a maximum width of about 2 inches near the cheek end.

The first frame member **23** may be manufactured from a durable, yet lightweight and flexible material. Durability is desired for stability in operation of the mount assembly and to withstand wear and tear during long term use. Light weight and flexibility are desired for comfort to the wearer during long term use. More specifically, the first frame member **23** may be manufactured from a plastic or polymer material, such as a polyamide resin system, and even more specifically, the first frame member may be manufactured from nylon 6/6.

The first frame member **23** has an exterior surface **46** (see FIG. 4b) and an interior surface **48** (see FIG. 4a). In one embodiment, the exterior surface **46** may be smooth and streamlined in order to enable it to avoid snag hazards. The interior surface **48** may include ribs **50**. The ribs **50** serve to add rigidity to the frame member **23**. A greater number and denser concentration of ribs **50**, as well as thicker ribs, may be used to provide the frame member **23** with greater rigidity. Greater rigidity is desirable at the hinge end of the frame members to provide stability for operation of the mount assembly. Whereas, greater flexibility is desirable at the cheek end of the frame members to allow for adjustment to conform comfortably to a wearer's face. The interior surface **48** may also include circular protrusions **52** which serve as a

base for snap attachment members **54**. Snap attachment members **54** are adapted to receive snaps **64** (discussed in more detail later) and may be attached to either or both the exterior and interior surfaces **46, 48** of the frame members **23, 24**.

The bridge **26** serves to connect the first frame member **23** to the second frame member **24** and also serves as a base for the mount assembly **80**. The bridge may be substantially rectangular and has two arms **82** extending laterally from each side. The arms **82** are adapted to fit into the recess **32** of the first and second frame members **23, 24**. A circular cross section opening **84** runs through the center of each arm **82**. When the arms **82** are inserted into the recess **32** of the frame members **23, 24**, the opening **84** in the arm may be aligned with the openings **34** and **38** in the upper and lower cylinders **28, 30** of the frame members **23, 24** to allow the hinge pin **36** to be inserted therethrough. Additionally, the opening **84** in the arm **82** may include a stop pin **88** or other stop feature (see FIG. 5). In one embodiment, the stop pin **88** comprises a cylindrical dowel, preferably made of metal, coaxial to the opening **84**, wherein the stop pin **88** partially protrudes into the otherwise circular cross section opening.

The frame assembly could be formed in a single piece in an open configuration adapted to fit on a wearer's face. However, to allow the frame assembly to be folded into a more compact configuration for storage, the frame assembly may be comprised, as shown in the drawings, of multiple pieces that are hinged for rotation relative to one another.

A foldable frame assembly may further comprise two hinge pins **36**. The hinge pins **36**, in a particular embodiment, may include a hexagonal head **92** and a generally cylindrical shaft or body **94**. The body **94** may further include a flat **90**. The exact shape of the hinge pin **36** in this particular foldable embodiment is not critical, but rather the pin should be

shaped such that it corresponds to the shape of the openings **34, 38, 84** and also so that it does not rotate relative to the frame members but does allow the frame member to rotate through at least some range of motion relative to the bridge.

In a foldable embodiment of the present invention, the frame members **23, 24** are rotatable. When the hinge pin **36** is inserted through the openings **34, 38, 84**, the stop pin **88** in the bridge opening **84** acts to restrict the rotatability of the hinge pin **36** to a particular range of motion. More specifically, when the frame members **23, 24** are rotated, the flat **90** of the hinge pin **36** pivots relative to the stop pin **88** in a limited range of motion rather than being able to rotate freely for 360 degrees. At one end of that range of motion, the frame members are positioned relative to the bridge to be at the optimal open configuration for use by a wearer. At the other end of that range of motion, the frame members are positioned relative to the bridge to be at the optimal closed configuration for storage.

Additionally, the bridge **26** may include two snap attachment members **54** which allow the attachment of a brow pad (discussed in more detail below). In one embodiment, the bridge **26** is made from aluminum. However, the bridge **26** may be made from any lightweight, durable and rigid material.

The bridge **26** may also be adapted to serve as the base for a mount assembly **80**. In one embodiment, the mount assembly **80**, to which night vision goggles (not shown) are attached, may have three positions. A first, or use, position allows a user to see out of night vision goggles attached to the mount assembly **80**. A second, stowed or flipped-up, position allows the user to move the mount assembly **80** above their head so that the goggles do not interfere with the user when they are not needed. A third, or storage, position allows a user to fold the mount assembly **80** back over the

first and second frame members **23, 24** to form the most compact orientation of the facemask assembly **10** for storage.

5 Padding may be attached to the interior surface of the frame members **23, 24** to provide comfort for the facemask assembly user. In one embodiment, a pad **62** may include an outer protective sheath and two layers of foam to provide for maximum comfort. A first layer **56** of foam, away from the
 10 user's face, may be a polyurethane foam and may have a thickness of about 0.25 inch, a density of about 15 lbs/cu. ft and a compression of about 1 to 5 psi. Specifically, the first layer **56** of foam may be Poron. A second layer **58** of foam, closest to the user's face, may also be a polyurethane foam and may
 15 have a thickness of about 0.5 inch, a density of about 2 lbs/cu. ft and a compression of about 0.7 psi. Specifically, the second layer **58** of foam may be Unifoam. The first and second layers of foam **56, 58** may be attached together by an adhesive or by any other appropriate means of securing them together. The second layer of
 20 foam is designed to form itself around the facial features with minimal pressure applied. The first layer of foam allows for additional cushioning as needed where increased pressure is created by tightening the facemask to the face in order to hold it securely during operation.

25 In an alternate embodiment, the second foam layer **58** is replaced by an air bladder (not shown). The air bladder may have similar thickness, density and compression qualities as the second layer of foam **58**.

 Adjacent to the first layer **56** of foam may be a first molded
 30 backplate **60** which serves as a base for the foam layers **56, 58** and as a means to which the outer protective sheath or a covering **66** may be attached. The first molded backplate **60** may be molded to follow the contour of the part of the frame member **23, 24** to which it will be attached. The first molded backplate **60** may be manufactured from
 35 nylon 6/6 or any other appropriate lightweight and durable material.

5 The covering 66 may surround the two layers of foam 56, 58 and the first molded backplate 60. Preferably, the covering 66 is durable yet comfortable when it is in contact with human skin for extended periods of time. In one embodiment, the covering 66 is sheepskin leather and may be attached to the first molded backplate 60 by an adhesive or any other appropriate means of attachment.

10 A second molded backplate 61 serves to hold means to attach the pad 62 to the facemask assembly 10 and to shape the surface of the pad 62 adjacent to the facemask assembly. The second backplate 61 may be attached to the covering 66 and/or the first molded backplate by an adhesive or any other appropriate means of attachment. Further, the second molded backplate 61 may be
15 manufactured from the same material as the first molded backplate 60.

20 The pads may be fixedly attached to the facemask. In one alternative embodiment, the pads 62 may removably attached to the facemask assembly 10 by snaps 54/64. The snap system provides a robust means of retaining the pads 62 to the frame assembly 20 as well as an easy method for removing the pads to allow for easier cleaning of dirty pads or replacing worn pads. At least one snap 54/64 is attached to a pad 62, and in one embodiment, two snaps 54/64 are attached to each pad. Having two snaps 54/64 provides
25 added security against a pad 62 inadvertently detaching from the facemask assembly 10. Alternately, the pads 62 may attach to the facemask by VELCRO ® or by any other attachment means that securely attach the pads to the facemask assembly, yet allow the pads to be easily and quickly removed and reattached.

30 The number of pads 62 on the facemask assembly 10 is not critical. However, there should be enough pad surface area to make the facemask assembly 10 comfortable to wear for extended periods of time by distributing pressure over a wider surface, but not so much pad surface area so as to make the facemask
35 assembly 10 too bulky for compact storage.

One embodiment of the present invention includes five pads: first and second cheek pads **68, 70** and first, second and third brow pads **72, 74, 76**. The first and second cheek pads **68, 70** attach to the cheek end **44** of the first and second frame members **23, 24** respectively and are positioned to rest in the hollow of the user's cheek below the cheek bone and above the jaw bone when the facemask assembly **10** is worn. The first and second brow pads **72, 74** attach to the body of the first and second frame members **23, 24** respectively, adjacent the hinge end **27**. The third brow pad **76** attaches to the bridge **26**. The brow pads are positioned to rest on a user's forehead above the sinus cavities, eyebrows and other sensitive areas near a user's eyes. In a particular embodiment, the first, second and third brow pads **72, 74, 76** may be connected together by a ribbon **78** which is placed between the first and second molded backplates **60, 61** and may be secured there by an adhesive. The ribbon **78** serves to keep the brow pads **72, 74, 76** together as one unit, making them more difficult to misplace.

In one embodiment of the present invention, the frame assembly **20** is transformable between a storage position and a use position. In the storage position, the frame assembly **20** may be folded down to a compact shape for storage in a carrying case (not shown). If the frame assembly **20** could not be formed into a compact storage position, the facemask assembly **20** would be difficult to store in a small compartment and would be more susceptible to damage during storage. The ability to fold the facemask assembly **20** into a compact shape helps to minimize the bulk of equipment the user must carry as well as to protect it while it is in storage.

In the storage position, the frame members **23, 24** are positioned such that the first cheek and brow pads **68, 72** are adjacent the second cheek and brow pads **70, 74**, i.e., the

angle formed by the bridge **26** and each frame member **23, 24** is about 90 degrees or less. In a particular embodiment, pads **68** and **72** will touch pads **70** and **74**, respectively, in the storage position. The stop pin may restrict further motion so that the pads will not be damaged during storage by being crushed into one another or other parts of the facemask. On the other hand, in the use position, the frame members **23, 24** are rotated such that when worn by a user, the brow pads **72, 74, 76** will line the user's upper forehead and the cheek pads **68, 70** will rest in the hollows of the user's cheeks. In the use position, the angle between the bridge **26** and each frame member **23, 24** is about 145 degrees or more. In one particular embodiment, the angle between the bridge **26** and each frame member **23, 24** is about 180 degrees.

The shape of the frame assembly **20** is designed to accommodate most eyewear, including protective eyewear. The frame assembly **20** does not incorporate padding between the browpads and cheek pads, allowing the arms or straps of eyewear to pass between the frame members **23, 24** and the user's face. Since many users of night vision equipment use protective or corrective eyewear during operations, this enables most users to wear their eyewear in conjunction with the facemask assembly **10**.

The mount assembly **80** provides the functions of night vision goggles mounting, fore/aft adjustment, line-of-sight tilt adjustment, and flip-up/flip-down. It also incorporates a magnet module participating in the function which turns the night vision goggles off if the night vision goggles is removed from the mount assembly or flipped-up to the stowed position. These mechanisms are described in greater detail in U.S. Patent No. 5,914,816 to Soto, et al., which is incorporated by reference herein.

The neck pad assembly **98** is also designed for comfort and

stability. The neck pad assembly **98** serves as an anchor point for the facemask assembly **10** once the assembly is put on. Specifically, in one embodiment, all of the straps of the adjustment strap assembly **96** (described in more detail below) may connect into the neckpad assembly **98**. The neck pad assembly **98** grips the lower rear portion of the user's head providing stability to the frame assembly **10** and night vision goggles (not shown) during operations such as running, jumping and crawling. The particular shape of the neckpad assembly **98** is not critical. However, the neckpad assembly **98** should be of such a shape as to provide a stable anchor for the facemask assembly **10** as well as a comfortable support for the user. The materials used in the neck pad assembly **98** should provide strength and breathability to maximize ruggedness and comfort to the user during periods of extended operation. The neckpad assembly **98** may be manufactured from any flexible, yet durable material, for instance, nylon.

The adjustment strap assembly **96** as shown in FIG. 1 may comprise two upper side straps **100**, two lower side straps **102**, an upper center strap **104**, a chin cup **106**, and a protective pad **108**. All adjustment straps may be tightened by pulling the end of the adjusting strap towards the front of the head. At least one of the lower side straps **102** incorporates a quick-release buckle **116** enabling the user to quickly remove the facemask assembly **10** if necessary. This also enables the user to quickly don the facemask assembly **10** if the adjustment straps have been previously fit to his or her head.

The chin cup **106** is an open design adapted to generally conform to the shape of a human chin. The chin cup **106** may further include straps **110** extending from either side. The straps **110** may be removably attached to the chin cup **106** by snaps **62** or by any other appropriate attachment means. This design positions the user's chin in the chin cup **106** between

the two straps and securely holds the chin cup **106** in position during operation. The chin cup **106** is designed so that it cannot be assembled backwards or upside-down. Further, the shape of the chin cup **106** is symmetric both vertically and horizontally. The chin cup **106** may be manufactured from any durable but flexible material. For instance, the chin cup **106** may be made from nylon and may also incorporate sheepskin leather next to the user's skin for additional comfort.

Each adjustment strap may further incorporate a plastic self-locking buckle or ladder lock **112**, as commonly found on, for instance, straps on a backpack. The buckles **112** may preferably be easy to use and have a low profile shape. Each buckle **112** allows the adjustment strap to easily be pulled for tightening and then holds the strap in position until the user pulls out on the buckle. The low profile shape of the buckles **112** helps prevent the inadvertent release of the straps by external items such as underbrush and cables.

The protective pad **108** serves to protect the user's head from injury if the mount assembly **80** rotates past the stowed position and comes in contact with the top of the user's head while the user is wearing the facemask assembly **10**. The mount assembly **80** is designed to rotate past the stowed position to a storage position which configures the facemask assembly **10** for compact storage. However, the user may suffer an injury if the mount assembly **80** was able to strike the top of the head during maneuvers. The protective pad **108** incorporates a hard plastic shield **114** which distributes any force over a broad area and drastically reduces the possibility of a point impact to the user's head. The protective pad **108** may be made from a flexible durable exterior surface for ruggedness, a soft interior layer and a comfortable covering next to the user's head. For instance, the exterior may be nylon 6/6, the interior may be foam and the covering may be sheepskin

leather.

5 The adjustable strap assembly **96** can be configured into
at least two different configurations according to the user's
preference. A first configuration, as shown in FIG. 1,
includes the chin cup **106** and a second configuration, as shown
in FIG. 8, does not include the chin cup. These alternate
configurations give the user the opportunity to choose his or
10 her preferred configuration. Typical users' preferences vary
depending on the user's facial profile, their personal history
with night vision goggles equipment, and their operational
missions' requirements.

15 In the first configuration, the upper side straps **100** are
attached to middle snap locations on the frame assembly **20** and
the lower side straps **102** are attached to the chin cup **106**.
This leaves the upper snap locations and the lower snap
locations on the frame assembly **20** unused.

20 In the second configuration, the upper side straps **100**
are attached to the upper or middle snap locations on the
frame assembly **20** and the lower side straps **102** are attached
to the lower snap locations on the frame assembly **20**. This
leaves potentially the middle snap locations on the frame
assembly **20** and the chin cup **106** unused.

25 The straps may be made of any strong, durable and
flexible material. By way of example, the straps may be made
of a woven nylon mesh material.

30 The adjustment straps are easy to use and incorporate a
quick-release buckle for rapid removal. The strap assembly
also offers the user multiple mounting configurations making
the use of a chin cup optional. The night vision goggles
positioning provided by the mount assembly allows the user to
properly position the night vision goggles in front of their
eyes. The flip-up/flip-down mechanism provides the ability of
35 moving the night vision goggles into a stowed position when

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the night vision goggles needs to be removed from the user's
line-of-sight.

5 While the foregoing describes the preferred embodiments
of the invention, various alternatives, modifications and
equivalents may be used. For instance, the number of pads
used in the frame assembly **20** may be varied. Moreover, it
will obvious that certain other modifications may be practiced
10 within the scope of the appended claims.

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